

Question [1]: [25 mark]

(a) Convert the following numbers showing all steps.

[3 marks each]

$$(11010110001)_2 = (681)_{16}$$

$$(7D3.A)_{16} = (3723.50)_8$$

0111 1401 0011 . 1010
3723 . 50

$$(9)_{10} = (1011)_{6-2-2-1}$$

$(-30)_{10} = (11100061)_{1's \text{ complement}}$ use 8-bit word length

164 32 16 8 4 2 1
0 0 1 1 1 1 0 ← sign & Mag.

$$(11001111)_{10} \text{ 1's complement} = (11110000)_{10} \text{ 2's complement}$$

(b) Convert and add the following numbers in Binary Coded Decimal BCD [4 marks]

$(63)_{10} + (37)_{10} =$

37
63

100

0110 0011
0011 0111

1001 1000
 0110

+ 1010 0000
 0110

1000 0000
 0000

(c) Find the range of numbers which can be represented in 2's complement using 6-bit word length. [3 marks]

$$\left. \begin{array}{l} -2^{n-1} \rightarrow 2^{n-1} - 1 \\ -2^5 \rightarrow 2^5 - 1 \end{array} \right\} \quad [-32 \rightarrow +31]$$

(d) Add the following 2's complement numbers and indicate if over flow occur. [3 marks]

$$\begin{array}{r} 1111011 \\ + 1000111 \\ \hline 1000010 \end{array}$$

No other flow.

Question [2] : [20 marks]

(a) Simplify the following function: [10 marks]

$$F(A, B, C, D, E) = \{[(A \oplus C) \cdot (C \oplus C)] + (D \cdot D)\} \oplus \{(E \cdot E) \cdot [(C \oplus C) + (A \oplus B)]\}$$

$$= \bar{D} \oplus E$$

$\uparrow \qquad \uparrow$
 $5 \qquad 5$

(b) Simplify the following function using consensus theorem:

$$F(W, X, Y, Z) = (X + Y + Z)(W + X + Y)(W + Y + Z)(X' + Y' + Z') \quad [5 \text{ marks}]$$

$$= (W + X + Y)(W' + Y + Z)(X' + Y' + Z')$$

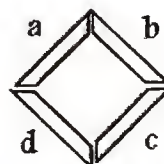
$$F(a, b, c, d) = a'c'd + a'bd + bcd + acd \quad [5 \text{ marks}]$$

$$= a'c'd + bcd + acd$$

$$\text{or} \quad = a'c'd + a'bd + acd$$

Pressing number 2 key would produce an Up indication, by lighting the segments a and b.

Pressing number 4 key would produce a left indication, by lighting the segments a and d.



Pressing number 1 key would produce a LU indication, by lighting the segment a.

Pressing number 7 key would produce a LD indication, by lighting the segment d.

Pressing number 9 key would produce a RD indication, by lighting the segment c.

Assume that only the above mentioned keys work and all other keys on the keyboard are disabled.

For the above problem do the following;

a. Construct the truth table of the system.

	A	B	C	D	A	b	C	d	\bar{A}
0	0	0	0	0	X	X	X	X	X
1	0	0	0	1	1	0	0	0	1
2	0	0	1	0	1	1	0	0	1
3	0	0	1	1	0	1	0	0	1
4	0	1	0	0	1	0	0	1	0
5	0	1	0	1	X	X	X	X	X
6	0	1	1	0	0	1	1	0	1
7	0	1	1	1	0	0	0	1	0
8	1	0	0	0	0	0	1	1	0
9	1	0	0	1	0	0	1	0	1
	1	0	1	0	X	X	X	X	1
	1	0	1	1	X	X	X	X	X
	1	1	0	0	X	X	X	X	X
	1	1	0	1	X	X	X	X	X
	1	1	1	0	X	X	X	X	X
	1	1	1	1	X	X	X	X	X

b. Find the Minterm expansion of segment c in decimal notation.

$$c = \sum m(6, 8, 9) + \sum d(0, 5, 10, 11, 12, 13, 14)$$

c. Find the Maxterm expansion of segment d in decimal notation.

$$\bar{d} = \prod M(4, 7, 8) \cdot \prod D(0, 5, 10, 11, 12, 13, 14)$$

$$d = \prod m(1, 2, 3, 6, 10, 11, 12, 13, 14)$$

d. Find the minimum sum of products for segment b.

AB \ CD	00	01	11	10
00	X	0	X	0
01	0	X	X	0
11	1	0	X	X
10	1	1	X	X

$$b = c\bar{d} + \bar{b}c$$

7P

12

1

13

12

$$\begin{aligned} & \sim AB\bar{C}D + A\bar{B}C\bar{D} + \bar{A}B\bar{C}\bar{D} \\ & \sim A\bar{B}C + \bar{A}C\bar{D} \end{aligned}$$

Question [4]: [25 mark]

A logical function is given as:

$$F(a,b,c,d) = \prod M(0,2,5,7,10) \cdot \prod D(8,13,14)$$

- Using K-Map find the **minimum SOP** and **minimum POS** expressions of the function.
- Realize the **minimum SOP** expression (obtained in part a) with **three-level only 2- input NAND gates** circuit.
- Realize the **minimum POS** expression (obtained in part a) with **two-level only NOR gates** circuit.

ab \ cd	00	01	11	10
00	0	1	1	X
01	1	0	X	1
11	1	0	1	1
10	0	1	X	0

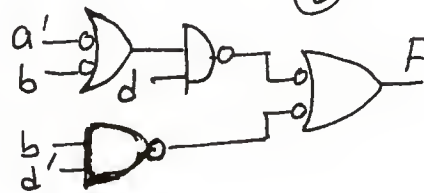
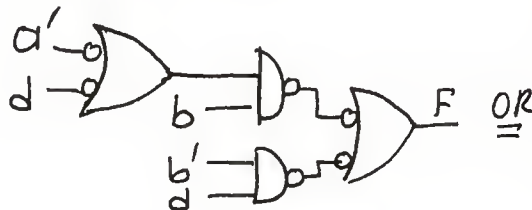
a) $F = ab + b'd + bd'$ or
 $F = b'd + bd' + ad$

(8)

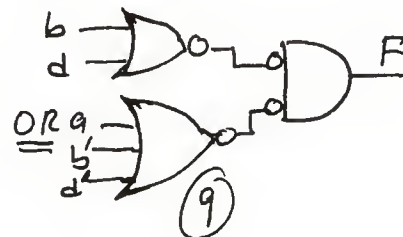
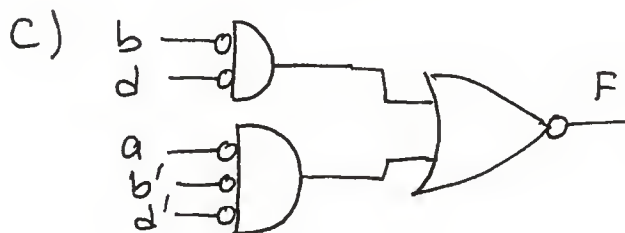
$$\bar{F} = b'd' + a'bd$$

$$F = (\bar{F})' = (b'd' + a'bd)'$$

b) $F = b(a+d') + b'd = d(a+b') + bd'$



(8)



(9)